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Trial Analysis Tools Final Report

A Call-Up Under the Noise Monitoring Standing Offer

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Contract Scientific Authority: James A. Theriault (902) 426-3100 ext 376

Defence R&D Canada – Atlantic

Contract Report
DRDC Atlantic CR 2005-235
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Canada

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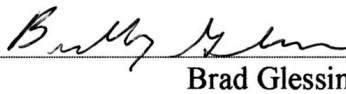

Brad Glessing

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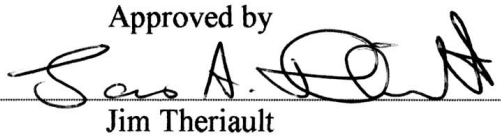

Jim Theriault

Scientific Authority

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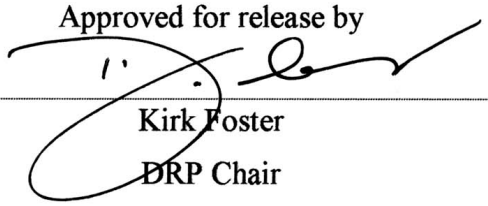

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Abstract

This report documents the work done to aid in the production of reconstruction products that provide a summary of scientific trials. During this call-up an analysis tool was created to support production of these trial summary reports. The resulting analysis tool was designed to be extendable so that future call-ups could easily reuse it. In addition, several enhancements were made to the existing Interactive Data Language (IDL)-based Software Tools for Analysis and Research (STAR) software, to support the new trial reconstruction tool.

Résumé

Ce rapport documente le travail accompli pour aider à produire des produits de reconstruction qui fournissent un sommaire d'essais scientifiques. Durant cette commande, un outil d'analyse a été créé afin de soutenir la production de ces rapports sommaires d'essais. Cet outil d'analyse a été conçu pour être extensible de sorte qu'on puisse le réutiliser dans des commandes à venir. En outre, plusieurs améliorations ont été apportées au logiciel Software Tools for Analysis and Research (STAR) articulé sur le langage Interactive Data Language (IDL), dans le but de soutenir le nouvel outil de reconstruction d'essai.

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Executive summary

Introduction

Software Tools for Analysis and Research (STAR) and Signal Processing Packages (SPPACS) have been in use by a number of groups at DRDC Atlantic over recent years. The STAR suite is implemented using the Interactive Data Language (IDL), though the design is not restricted to IDL. Applications in the STAR suite are built using a combination of reusable and custom components that meet the requirements of each application. The layered design and common components allow for rapid and logical development of new capabilities. As time has progressed, individual enhancements to STAR have been made available to the general users.

This report describes the enhancements to STAR to enable the efficient analysis of Non-Acoustic data associated with multistatic sonar experiments.

Results

The work carried out under this contract enhanced the STAR package by creating a capability to output a number of non-acoustic data products. These include *Course vs. Time, Speed vs. Time, Cable Scope vs. Time, Source Depth vs. Time, Receiver Depth vs. Time,* and *Ping On/Off/Type vs. Time (Color Coded Time Graph)* for a single platform. For multiple platforms, output products such as *Relative Range vs. Time, Relative Bearing vs. Time,* and *Relative Doppler vs. Time* are now available.

Significance

The enhancements to STAR completed under this contract allow for the efficient identification of acoustic data for further detailed analysis. Sorting through the non-acoustic data is usually a time-time consuming venture, which has been made more efficient through the implementation of these enhancements.

Glessing, Brad; Macmichael, Cory; and Burnett, Derek. 2005. *Trial Analysis Tools Final Report.* DRDC Atlantic CR 2005-235. Defence R&D Canada – Atlantic.

Sommaire

Introduction

Software Tools for Analysis and Research (STAR) et Signal Processing Packages (SPPACS) ont été utilisés par de nombreux groupes à RDDC Atlantique au cours des dernières années. La suite STAR est mise en œuvre à l'aide du langage Interactive Data Language (IDL), bien que le concept ne soit pas restreint à IDL. Les applications de la suite STAR sont créées au moyen d'une combinaison de composants réutilisables personnalisés qui répondent aux exigences de chaque application. La conception en couches et les composants communs permettent le développement rapide et logique de nouvelles fonctions. Au fil du temps, les diverses améliorations apportées à la suite STAR ont été mises à la disposition des utilisateurs généraux.

Le présent rapport décrit les améliorations apportées à la suite STAR afin de permettre l'analyse efficace des données non acoustiques reliées aux expériences faites avec le sonar multistatique.

Résultats

Les travaux exécutés en vertu de ce contrat ont amélioré le progiciel STAR par la création d'une fonction de sortie de nombreux produits de données non acoustiques. Ces données sont les suivantes : *Course vs. Time, Speed vs. Time, Cable Scope vs. Time, Source Depth vs. Time, Receiver Depth vs. Time* et *Ping On/Off/Type vs. Time (Color Coded Time Graph)* pour une plateforme unique. Dans le cas de plateformes multiples, des produits de sortie comme *Relative Range vs. Time, Relative Bearing vs. Time* et *Relative Doppler vs. Time* sont maintenant disponibles.

Importance

Les améliorations de STAR effectuées en vertu de ce contrat permettent l'identification efficace de données acoustiques à des fins d'analyse détaillée complémentaire. Le tri parmi les données non acoustiques est généralement une activité qui prend beaucoup de temps, mais dont l'efficacité a été grandement augmentée par la mise en application de ces améliorations.

Glessing, Brad; Macmichael, Cory; et Burnett, Derek. 2005. *Trial Analysis Tools Final Report.* RDDC Atlantique CR 2005-235. R & D pour la défense Canada – Atlantique.

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1. Introduction

This final report outlines the work done under Noise Monitoring Software Regional Individual Standing Offer (RISO) No. W7707-032293/A, Trial Analysis Tools Call-up Requisition No. W7707-04-2638. This work was performed at Defence R&D Canada (DRDC) - Atlantic under the direction of the Scientific Authority (SA), Jim Theriault, from approximately September 2004 to March 2005.

1.1 Overview

The objective of this call-up was to extend existing STAR non-acoustic data (NAD) parsing capability and database functions. Extensions included parsing of Non-Acoustics Data Acquisition System (NADAS) formatted data, new database queries and new report product options.

This report is broken into four main sections. The remainder of this section provides background on the software used during the call-up. Section 2 provides an overview of the call-up requirements and work performed to meet those requirements. Section 3 details software configuration management processes and the versions used for this call-up. Section 4 provides a summary of current software issues.

1.2 Background

The data processing and analysis work was performed using two software suites: STAR and Signal Processing Packages (SPPACS). An overview of the two software suites is provided in the following subsections.

The STAR and SPPACS suites are configuration controlled using the concurrent versioning system (CVS), and issue and enhancement idea tracking is affected using the Bugzilla issue tracking software. CVS is a repository that allows developers to check-in revisions to software and documentation where they are archived in a common database. The tool allows all previous versions of the software to be maintained and aids resolution of new issues, while ensuring that current builds of the software are readily accessible to users and developers alike. Bugzilla is a web accessible database that offers both user and developer input to issues, priorities and solutions. It provides coherent tracking and recording of an issue over its entire lifecycle.

STAR and SPPACS components are documented in a combination of formats, each with their own purpose. Microsoft Word documents are maintained, which describe functionality and algorithms of components. These are primarily intended for the end user. Enterprise Architect (EA) files are maintained, which document software design, interaction and dependencies. EA design information is intended primarily for developers. Hypertext Markup Language (HTML) library documentation is being developed that provides automatic extraction of the routine's Application Programming Interface (API), purpose and description. This documentation is maintained to assist developers in familiarizing themselves with the existing libraries and components, and is intended to support and encourage software reuse. Some users may also wish to refer to this information for use in their own custom applications. SPPACS also provides HTML and main page user documentation for each module.

The most current status of the SPPACS and STAR suites can be found at https://star.iotek.ns.ca. Users are also encouraged to refer to the electronic documentation provided with the software distribution for up-to-date information.

1.2.1 STAR

The STAR suite was developed to support general research and analysis objectives at DRDC Atlantic. The primary objectives of the STAR suite are:

- Provide scientific grade analysis tools that allow for efficient, detailed quantitative and qualitative analysis of a data set.

- Support synergy between DRDC groups and the Department of National Defence (DND) by providing a common software base for analysis. This synergy encourages inter-group communication and simplifies user training, analysis process development, documentation and data portability.

- Support cost and analysis efficiency by providing software reuse and common tools and data formats. Examples of efficiency would be using the output of analysis from one group to feed the inputs of another, or using common software components to lower development cost of several custom analysis tools.

All STAR components are currently implemented using IDL, though the design is not restricted to IDL. The name STAR reflects the generic nature of the software. Applications in the STAR suite are built using a combination of reusable and custom components that meet the requirements of each application. The layered design and common components allow for rapid and logical development of new capabilities. Though currently focused on sonar data processing and analysis, the tools are capable of expanding to meet other analysis and research requirements.

1.2.2 SPPACS

SPPACS is a group of software programs that are based on the C programming language and is implemented on Linux-based personal computer (PC). Each program provides a specific processing function and a series of programs can be chained together to create a custom-processing stream using the command line or scripts. The output from SPPACS is stored in DREA formatted data files. SPPACS has slowly evolved to its present day state due to the efforts of several MacDonald Dettwiler and Associates Ltd. (MDA) personnel over the last 4 years.

SPPACS has been used to perform a number of mid-trial and post-trial processing functions, such as the post-trial study of multistatic trial data and the mid-trial analysis of the Q265 sonobuoy test trial. SPPACS only performs data manipulation and does not provide an interface to examine the results. The processed data output is often imported into other applications that enable data display and are used to perform the detailed analysis of the results. One example of such an application is the STAR suite.

The SPPACS software suite consists of two types of software. One type is runtime executables that can be used to process DRDC Atlantic data files in a number of ways, including data management and signal processing. Each program performs a specific function and the programs are designed so that they can be used in conjunction to perform more complex processing tasks. The software has proven to be very useful in simplifying data management and sonar processing

tasks by providing a set of tools from which to build the necessary processing streams. These streams can be run from the command line or assembled into scripts to perform batch-processing tasks allowing for large amounts of data to be automatically processed. The second form of the software is a group of library functions that can be used by other programs to efficiently perform standard tasks. These library functions are extensively used by the runtime software, but can also used for other applications. There are now three types of libraries. The first are utility routines for performing tasks, such as header manipulation and command line parsing. The second are signal processing modules termed signal processing library (SPLIB). These are low-level modules, each performing a low level signal-processing task. A new SPPACS module typically consists of one or more SPLIB modules linked together with an SPPACS user interface. The final library type is a sonar processing module termed sonar library (SONLIB). These are more complex modules that combine several SPLIB modules to create a complex sonar module, such as passive processing. Separating the SPLIB and SONLIB modules from SPPACS generated more generically reusable software. SPLIB and SONLIB are independent of the data header format, timestamping method, etc., and are suitable for integration in real-time processing systems.

SPPACS is also supported by a set of signal processing libraries known at the Fastest Fourier Transform in the West (FFTW). These free, open-source libraries provide optimized signal processing functions helping to ensure that the SPPACS software runs as efficiently as possible, while providing a significant reduction in coding effort.

2. Work Overview

This section presents an overview of the tasked work and a summary of the work that was completed. The development requirements for this call-up are listed in Table 1. Some data processing and analysis was also performed during this call-up.

A detailed description of the technical aspects related to the work performed under this contract can be found in the primary STAR reference, "The Software Tools for Analysis and Research Data Analysis and Technical Manual - Revision 1" [R-1]. This document provides details, such as the algorithms used to perform the various analysis measurements, and recommends a complete analysis process that can offer significant improvements in efficiency to DRDC Atlantic.

As this contract was restricted by a limitation of expenditure and the contract objectives were ambitious, not all requirements were completely implemented, though substantial progress was made. MDA worked with the SA to ensure that the call-up deliverables were satisfactory allowing trade-offs to be made, as required.

Several accomplishments described in this contract rely on work conducted under other contracts. By sharing a common code base, several contracts were able to reduce the amount of effort required to meet their individual requirements and realise more overall benefit with the available funds.

The following work was completed to address the requirements listed in Table 1:

Table 1. *Contract Requirements*

REQUIREMENT TITLE	ASSOCIATED REQUIREMENTS
Trial Reconstruction Product Generation:	• The contractor shall generate parsers and database entries for the data identified during Task 1 analysis.
Query Generation:	• The contractor shall generate database queries to retrieve the following information from the database: o Time sorted Target data structure for a given time range o Time sorted Source data structure for a given time range o Time sorted Receiver data structure for a given time range o Time sorted Track data structure for a given time range o Available Track list o Available Source list o Available Target list o Available Recorder list o Available Receiver list • The contractor shall generate a function that returns relative range, bearing and Doppler for a given time range given two arrays of time stamped positional data. This shall involve linear positional and time interpolation to ensure that the same time is used for relative calculations.

Table 1. *Contract Requirements*

REQUIREMENT TITLE	ASSOCIATED REQUIREMENTS
Trial Reconstruction Product Generation:	• The contractor shall generate a trial reconstruction product generation application that allows the user to produce the following plots for a user selected source, target, recorder/receiver or track of interest for a given time range (as applicable): o Course vs. Time o Speed vs. Time o Cable Scope vs. Time o Source Depth vs. Time o Receiver Depth vs. Time (as applicable) o Ping On/Off/Type vs. Time (Color Coded Time Graph) • The contractor shall generate a trial reconstruction product generation application that allows the user to produce the following plots for any combination of two user selected sources, targets, recorder/receivers or tracks of interest for a given time range: o Relative Range vs. Time o Relative Bearing vs. Time o Relative Doppler vs. Time • The contractor shall allow the optional output of all plot products to an encapsulated postscript file. • The contractor shall allow the optional output of all plot data to an ASCII file with an appropriate header defining the data source.

2.1 Trial Reconstruction Product Generation

After consultation with the SA, it was decided that only NADAS format parsers would be written during this call-up. This was due to difficulties in obtaining documentation on the National Marine Electronics Association (NMEA) format. As a result, examination of the commonality between the NADAS and NMEA formats and parsing routines for the NMEA format could not be completed under this call-up.

2.2 Query Generation

Database queries were generated to retrieve information from the tactical database. The new queries are part of a new tactical database layer written around the existing tactical database API. This approach allowed the tactical database to be extended to use NADAS parsed data while maintaining backwards compatibility with existing software. The queries were written as generic routines that can be reused and extended for future call-ups. Queries supporting the following data sets were completed under this call-up:

- Time sorted Target data structure for a given time range
- Time sorted Source data structure for a given time range
- Time sorted Receiver data structure for a given time range
- Time sorted Track data structure for a given time range
- Available Track list
- Available Source list
- Available Target list
- Available Recorder list
- Available Receiver list
- Relative range, bearing and Doppler for a given time range given two arrays of time stamped positional data. This involved linear positional and time interpolation to ensure that the same time is used for relative calculations.

2.3 Trial Reconstruction Product Generation

A tool was created to allow the user to generate trial reconstruction products. The tool consists of a query window (as shown in Figure 1) and multiple plot windows (as shown in Figure 2). When the operator selects a query type the contents of the query window, below the *Send Query to Plot* button, will be updated to match the query type. The operator can then modify the query settings and send the query using the *Send Query to Plot* button. The data retrieved by the query will be sent to a new plot window if *New Plot Window* is selected in the second drop list. Alternatively, the data can be sent to an existing window by selecting a specific window from the same drop list. Note that the query to the right in Figure 1 was developed under BASE04. The data displayed in Figure 2 was produced from NADAS test data.

The functionality for each product is localized to retrieval and data policies. The policies are added to the trial reconstruction tool. This allows new products to be implemented and integrated with minimal changes to the existing tool.

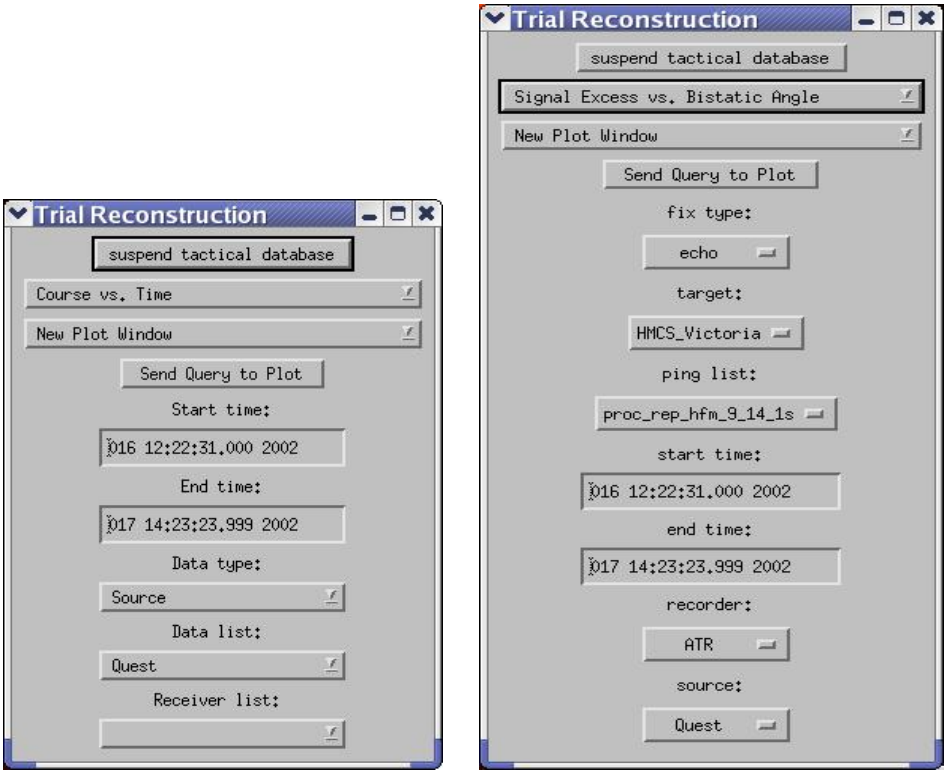

Figure 1. *Trial Reconstruction Tool –Query Window*

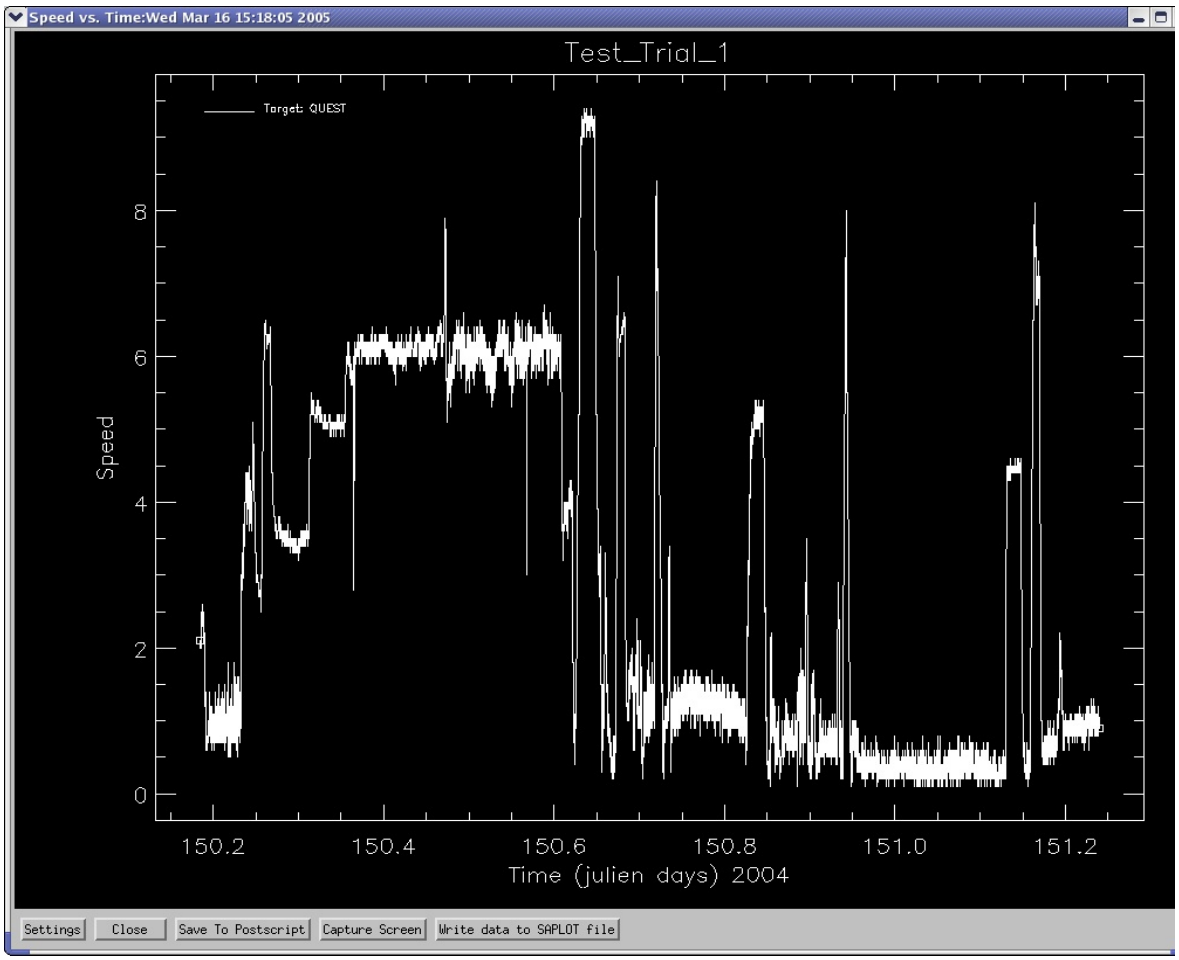

Figure 2. *Trial Reconstruction Tool – Plot Window*

The trial reconstruction product generation application allows the user to produce the following plots for a user selected source, target, recorder/receiver or track of interest for a given time range:

- Course vs. Time
- Speed vs. Time
- Source Depth vs. Time
- Receiver Depth vs. Time (as applicable)

Cable scope and ping could not be done as no NAD was immediately available to measure these items, and the current call-up did not have time to pursue these data sources.

The trial reconstruction product generation application allows the user to produce the following plots for any combination of two user selected sources, targets, recorder/receivers or tracks of interest for a given time range:

- Relative Range vs. Time
- Relative Bearing vs. Time
- Relative Doppler vs. Time

An option was implemented to allow the user to save a plot to an encapsulated postscript file. The postscript file can then import into another document (i.e., Word, PowerPoint, etc.).

After consulting with the SA, it was decided that the “save as ASCII” feature would output the plot data in the Surveillance Acoustic Plotting (SAPLOT) format. The output file was based on the SAPLOT Scientific Graphic Software User’s Manual [R-2], provided in the DRDC technical library. The SAPLOT code is distributed with STAR. Usage instructions can be found at: \\acoustics\doc\analysis_tools\idl_saplot.help.

3. Maintain Configuration Management

STAR and SPPACS are maintained using CVS. The most recently released version is maintained and bug fixes are applied to that version, as required, ensuring that a stable release is always available. Simultaneously, software enhancements are applied to the development version and bug fixes are merged with this version. Once a call-up nears completion or a release of the software is otherwise required, a new release version is branched off of the development stream for final integration, release testing and delivery.

STAR (includes SPPACS) release 4.6.0 (tag star_release_4_6_0) was created under this contract to serve as a baseline while the analysis work was being conducted. This allows development to continue on the trunk of the distribution. The trunk usually contains newly implemented software, which may not be stable enough to allow for operational use.

4. Track Software Issues

Defect Tracking Systems allow users to keep track of outstanding bugs in their product effectively. STAR and SPPACS issue tracking is performed using a web accessible tool called Bugzilla. This tool can be accessed using a secure web interface at https://star.iotek.ns.ca. Once the appropriate security procedures, detailed on the web page, have been followed, users and developers can use this site to add, view or modify issues related to the software packages.

A breakdown of the current issues for the STAR and SPPACS distributions are shown in Table 2. The total number of unresolved issues is shown in the NEW/ASSIGNED/ REOPENED column. The total number of opened issues is broken into two classes of severity. Issues classified as BLOCKER/CRITICAL/MAJOR are issues that should be addressed in the short term. Blockers are always addressed immediately to ensure that the user community can continue with their work. Issues classified as NORMAL/ MINOR/TRIVIAL are issues that can be dealt with in the long term.

Table 2. *Distribution Issue Summary (07/02/2005)*

PRODUCT	NEW/ASSIGNED/ REOPENED (TOTAL)	BLOCKER/CRITICAL/ MAJOR	NORMAL/MINOR/ TRIVIAL
SPPACS	35	1	34
STAR	53	4	49

The following gives a more detailed description of the SPPACS BLOCKER/ CRITICAL/MAJOR column:

- Issue # 284 (major) **fails DAT32 byteswap case.** The utility is attempting to read the extra gains using the original header, which may be in a different byte-order than the platform.

The following list gives a more detailed description of the STAR BLOCKER/ CRITICAL/MAJOR column:

- Issue # 193 (critical) **tacplot does not cleanup before exiting**. The work around for this issue is to run heap_gc after the analysis window has closed.

- Issue # 107 (major) **problems capturing close button**. A solution exists for this but has only been incorporated into the tactical plot.

- Issue # 295 (major) **capture screen doesn't work correctly.** The Capture Screen button does a screen capture on the analysis window and not the tactical plot. If the tactical plot is closed and reopened this will work. A fix is available in the next release.

- Issue # 329 (major) **overlays need to be optimized.** The tactical plot is too slow (on Bender). To load on Bender (dual P4- 1GHz), it takes approximately 20 seconds the first time and 15 to 20 seconds thereafter.

5. References

1. The Software Tools for Analysis and Research Data Analysis and Technical Manual – Revision 1

2. SAPLOT Scientific Graphic Software User's Manual

List of symbols/abbreviations/acronyms/initialisms

API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
CVS	Concurrent Versioning System
DND	Department of National Defence
DRDC	Defence R&D Canada
DREA	Defence Research Establishment Atlantic
DRP	Document Review Panel
EA	Enterprise Architect
FFTW	Fastest Fourier Transform in the West
HTML	Hypertext Markup Language
IDL	Interactive Data Language
MDA	MacDonald Dettwiler and Associates Ltd.
NAD	Non-Acoustic Data
NADAS	Non-Acoustics Data Acquisition System
NMEA	National Marine Electronics Association
PC	Personal Computer
RISO	Regional Individual Standing Offer
SA	Scientific Authority
SAPLOT	Surveillance Acoustic Plotting
SONLIB	Sonar Library

SPLIB	Signal Processing Library
SPPACS	Signal Processing Packages
STAR	Software Tools for Analysis and Research

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